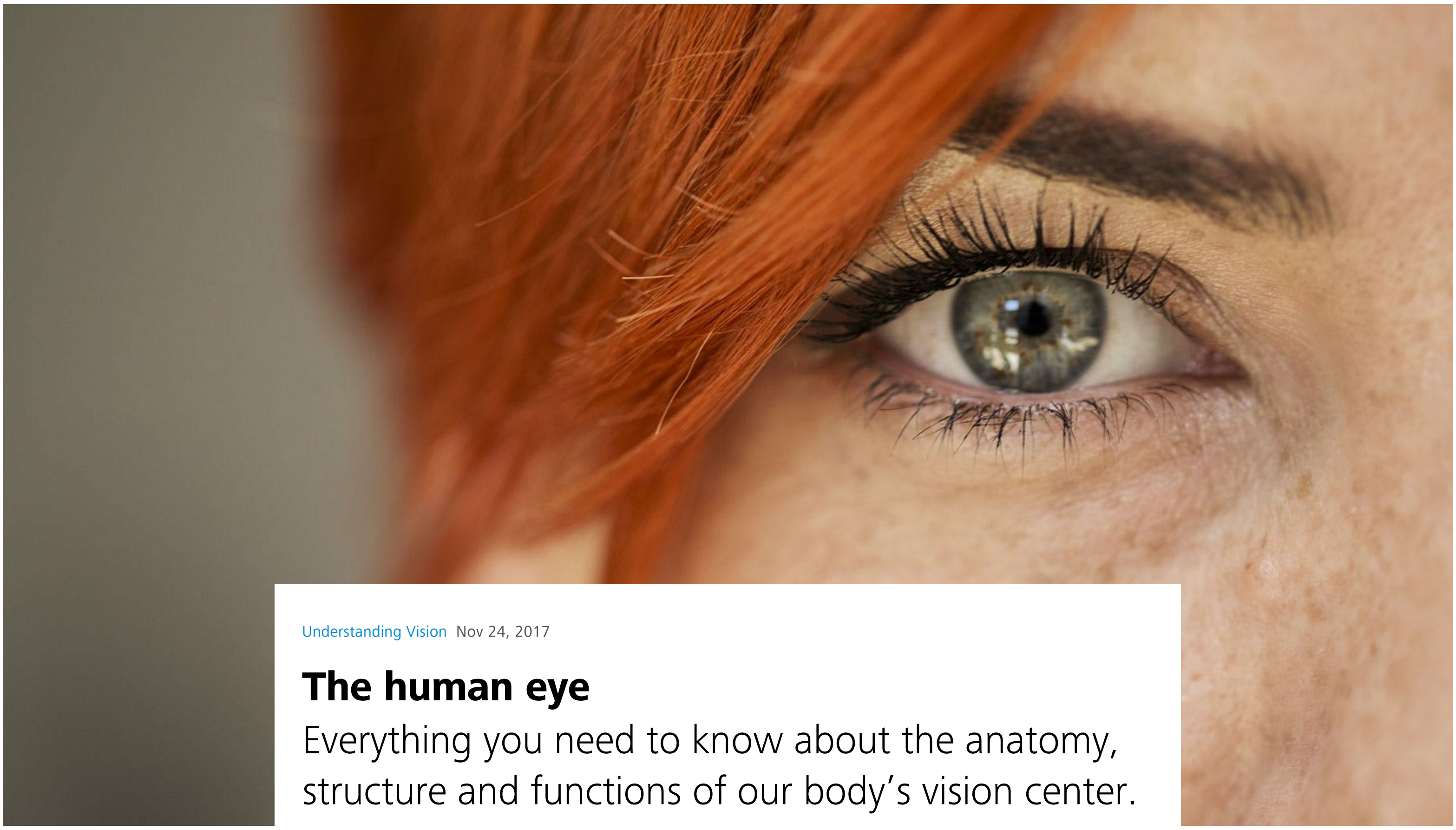


Understanding Vision Nov 24, 2017

# The human eye

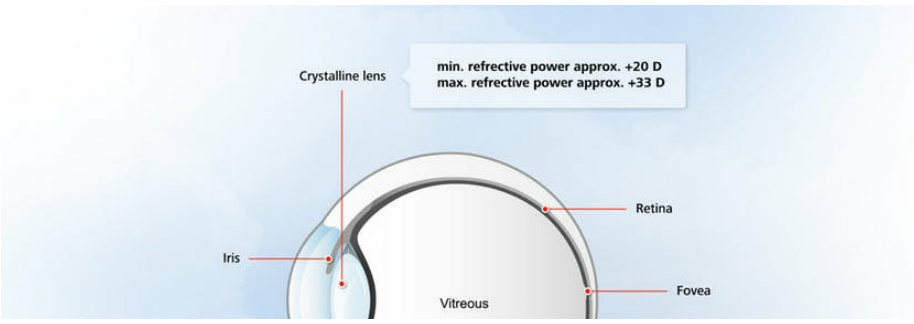
## Everything you need to know about the anatomy, structure and functions of our body's vision center.

**The eye is one of our most important sensory organs – hardly any another organ is as complex. The human eye is capable of absorbing and instantly processing more than ten million pieces of information per second. But have you ever thought about how the eye actually works? How are images that we see actually generated? And what parts of our body are involved in this intricate process? BETTER VISION gives us all the details – on everything from the eye's anatomy and structure to its functions.**

The eye works in much the same way as a video camera – put simply, its different parts work together to visualize the world around us. Read on to find out exactly how the eye works. But first, let's discuss the key parts of the eye and its structure.

Eye's anatomy The outer part of the human eye Vision explained

## Anatomy: the structure of the human eye




## Cornea

The cornea, the eye's external layer, is moist on account of the tear fluid that covers it. It is embedded in what's known as the sclera (white part of the eye); together, they form what experts call the tunica externa bulbi. The cornea acts like a window: it is disc-shaped and transparent, and allows light into the eye. It also protects the eye against external influences such as dirt, dust and superficial injury. It is naturally very resilient. What's more, its curvature lends it optical qualities and plays a key role in helping us see clearly.

## Sclera

The sclera – the white part of the eye – is thicker and stronger than the cornea and thus protects the eye from becoming damaged. It covers virtually the entire eye – with only two exceptions: at the front is the embedded cornea, while at the back are the optic nerve fibers.

## Pupils

The pupil is the black dot in the middle of the eye. It reacts to incident light and adapts to its intensity. It is not the pupils themselves but the iris that makes this possible. Our emotional state can also impact the size of our pupils. Fear and great joy, for instance, may cause our pupils to dilate, while alcohol and drugs also cause them to change in size.

## Iris

The iris, a colorful ring, surrounds the pupil and works in the same way as an aperture: it controls the amount of light that enters the eye. In a bright environment, it ensures that the pupil becomes smaller, thus allowing less light in. In the dark, the opposite happens: the pupillary sphincter muscle opens, and the pupil dilates. It thus ensures that more light can enter the eye when it's dark and that less light enters it in bright surroundings. The iris also determines the color of our eyes and is uniquely structured in every one of us. It's also named after the Greek goddess of the rainbow. Interestingly, the color of the iris has no impact whatsoever on vision. Someone with brown eyes doesn't see the world any "darker" than someone with lighter eyes, e.g. blue eyes.

## Eye chambers (camerae bulbi)

The human eye has anterior and posterior chambers. These are voids in its anterior segment that contain aqueous fluid. This fluid contains key nutrients for the lens and the cornea; it supplies them with oxygen and helps them fight off pathogens. The aqueous fluid in the eye's chambers has another job: it helps the eye retain its shape.

## The eye's lens (crystalline lens)

The eye's lens collects the light entering the pupil, thus ensuring a sharp image on the retina. It's elasticated and can adapt its shape using the ciliary muscle in order to focus on objects both close up and at long range. This means that when we look at objects nearby, the lens curves to enable clear vision. But when it comes to objects that are further away, it becomes flat – again, enabling us to see clearly. The lens turns the image we see on its head and visualizes it on the retina back to front. It's only turned "the right way round" when it's processed by the brain later on.

## Ciliary body and beam body (corpus ciliare)

The ciliary body plays a major role in terms of our sight: it produces aqueous fluid and contains the ciliary muscle (musculus ciliaris). By adapting the lens, it ensures that we can focus on both nearby and faraway objects.

## Vitreous body (corpus vitreum)

The inside of the eye between the lens and the retina is filled by the vitreous body. This constitutes the majority of the eye and, as the name suggests, represents its body. It is transparent and consists of 98 percent water, and 2 percent sodium hyaluronate and collagen fibers.

## Retina

The retina processes light and color stimuli in order to pass them on to the brain via the optic nerve. Put simply, the retina acts like a catalyst: it uses its sensory cells to convert the incoming light, which is then processed by the brain. These sensory cells consist of cones (for seeing in color) and rods (for recognizing light and darkness). Nowhere else in the eye are they so densely packed than in the center of the retina, or in the macula: some 95 percent of all sensory cells are located on an area of about 5 square millimeters. This is roughly the size of a pinhead.

### Choroid (chorioidea)

The choroid of the human eye is located between the sclera and the retina, and transitions to the ciliary body and the iris. It ensures a supply of nutrients to the receptors on the retina, keeps the retina's temperature constant and is also involved in accommodation, i.e. the shift between near and distance vision – in pretty much the same way a camera lens focuses.

### Optic nerve (nervis opticus)

The optic nerve is responsible for transferring information from the retina to the brain. It consists of around one million nerve fibers (axons), is approximately half a centimeter thick and exits the retina via the papilla. This point is also known as the "blind spot" as the retina has no sensory cells there. That's why the image generated by the brain is in fact a black dot – normally, our gray cells compensate for this to deliver a consistent view. However, this point is not usually consciously perceived as the brain "makes up for" the failure.

### Fovea/foveal pit (fovea centralis)

Small area, big impact: the foveal pit is less than two millimeters in size but assumes key tasks in our optical system. It is located in the center of the retina and is packed with sensory cells that enable us to see as clearly as possible and in color during the day. When we look at an object, our eyes automatically rotate so that it can be imaged on the fovea.

## The outer part of the human eye

The "parts around" the eye play a major role in helping us see: they are the lids, lashes, tear ducts and eyebrows.

### Tear ducts (glandula lacrimalis)

The tear duct: It's about as big as an almond, sits on the outside of the eye socket and produces tears when needed. Its secretion, which consists of salts, proteins, fats and enzymes, is used to supply and protect the cornea and help remove foreign bodies from the eye.

### Eyelids (palpebrae)

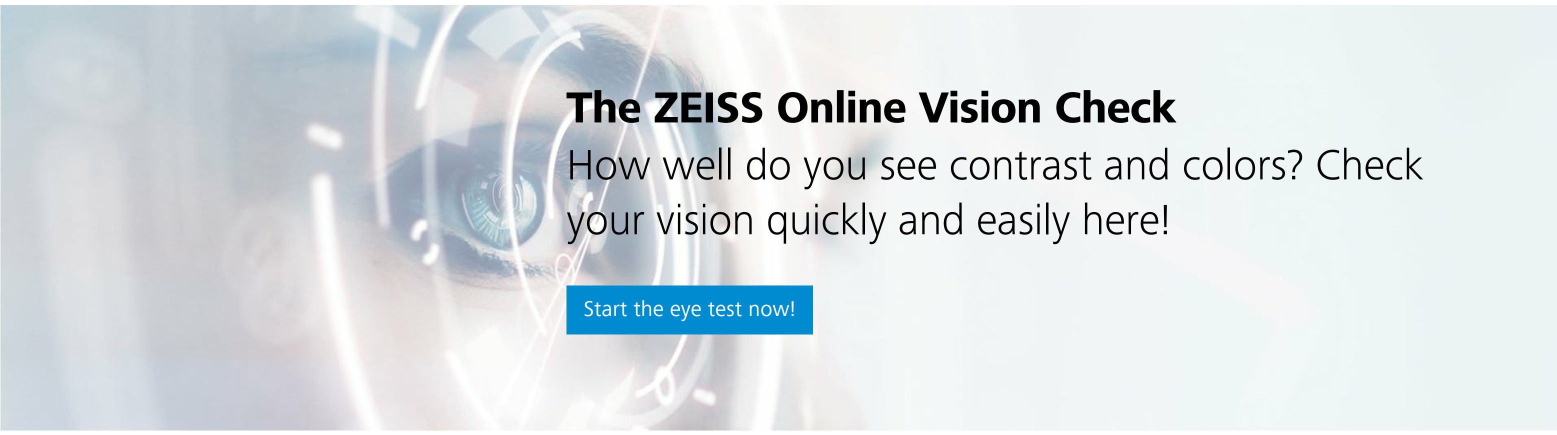
The lids moisten the eye each time we blink and they close as a reflex action in order to protect against the wind, liquids and foreign bodies. On average, people blink eight to twelve times a minute, which spreads tear fluid across the surface of the eye in fractions of a second. This moistens the cornea and stops it drying out.

### Eyelashes (cilia)

The lashes don't just look pretty, they have a practical function, too: their job is to fight off dust, dirt particles and other foreign bodies. This all happens automatically: as soon as the fine hairs come into contact with something or the brain expects this to happen, the lids close as a reflex action.

### Eyebrows (supercilium)

The eyebrows protect the eyes against sweat that may trickle down from the forehead.



# Vision explained: How the eye works

The way we see things is all part of a complex process: before we see something, a string of individual steps occur in the eye and the brain. We talk about the retino-cortical pathway, which begins at the eye and runs all the way to our brain. Put simply, vision happens like so: the human eye absorbs light from its surroundings and collects it on the cornea. This results in an initial visual impression. Then, each eye forwards this image to the brain via the optic nerve and processes it, resulting in what we call "vision." Light forms the basis of everything we see. In complete darkness, we are virtually blind.

Specifically, this means that if we are to even have a chance of seeing an object, some light has to fall on it. This light is then reflected back by the object and processed by our visual apparatus. If we look at a tree, our eyes absorb the light it reflects: the rays first penetrate the conjunctiva and the cornea. Next, they pass through the anterior chamber and the pupil. Then, the light arrives at the eye's lens, where it is collected and transferred to the photosensitive (=light-sensitive) retina. There, the visual information is gathered and sorted: the rods are responsible for light-to-dark vision, and the cones are in charge of clarity and colors. This information is transferred to the optic nerve, which takes it directly to the brain, where it is once again assessed, interpreted and consolidated to form the image that we ultimately see.

Even though we have detailed findings relating to the anatomy of the human eye and its structure, many questions about how our consciousness works remain very much unanswered. So while you know what parts of your brain are the most active when you see something, no one quite knows how we perceive the world as a result.

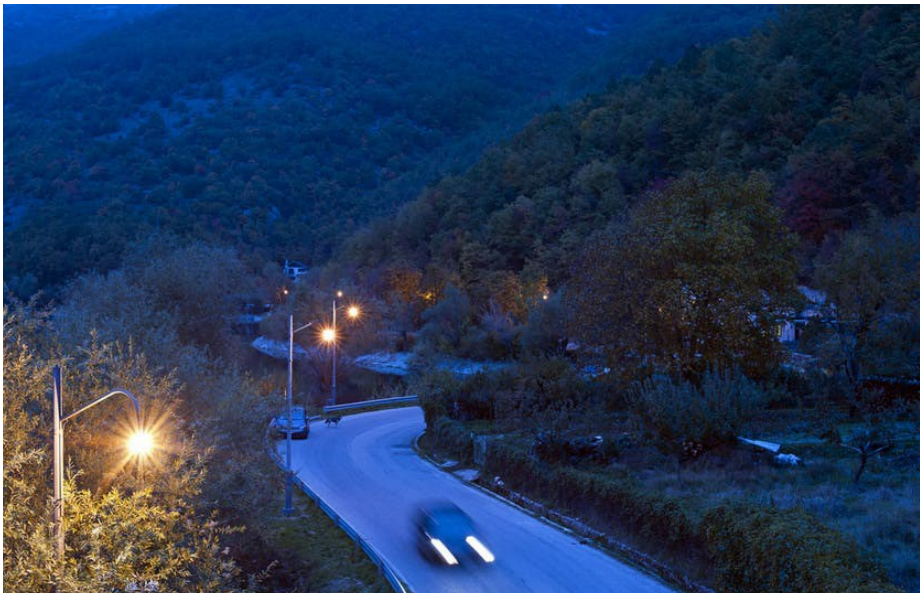
## Seeing things close up and far away

Healthy eyes do this automatically, without any help – so that we can switch between near and distance vision and see objects clearly at both distances. This dynamic ability to see objects clearly at different distances is known as accommodation. It is based on the elasticity of our eye's lens. As long as there is no impairment, it can change its shape and thus adapt to objects close up or far away, depending on what we want to see. A normal eye's lens is flat and long – which is ideal for looking at objects in the distance. But if we look at an object close up, the lens becomes more curved: it switches to close range and allows us to see nearby objects clearly. Accommodation is always triggered when objects appear blurred on the fovea.

## Seeing objects during the day – how our eyes work

Seeing objects when there's plenty of light (photopic vision or daytime vision) is a task assumed by the sensory cells responsible for color vision: the cones. The pupil is also involved in daytime vision: the brighter it is, the smaller the pupil becomes. It adapts to different light intensities and regulates the amount of light that enters the eye. This quality is known as adaptation. > Sunglasses and tinted lenses can protect the eye against bright light.

## Night and dusk vision



At night, our eyes switch from daytime vision (photopic vision) to nighttime vision (scotopic vision). Healthy eyes need around 25 minutes to adapt to the dark. The less light that's available, the more active the eye's sensory cells will become; they're responsible for our light-to-dark vision and are known as rods. At the same time, the pupils widen to "let in" as much light as possible. Healthy eyes have no trouble adapting to changing light conditions. Hereditary diseases, certain medication, injuries and a vitamin A deficiency can all result in limited vision at night or dusk. This is a problem that affects many people who wear glasses. Pupils need to dilate more in reduced lighting conditions. As a result, depth of field is lost and spatial vision limited, while reflections and poor contrast tire the eyes. > i.Scription® technology from ZEISS factors the wearer's dilated pupils at night into the lens design, which considerably improves visual performance in low light.

And did you know that our light-and-dark vision also plays a role when it comes to safety on a plane? During takeoff and landing, the cabin lights are dimmed so that passengers' and crew members' eyes can adapt immediately to the new light conditions in the event of a crash. This can save precious seconds in an emergency.

## Vision problems and eye diseases – what to do if your vision is restricted

Short-sightedness, long-sightedness, presbyopia – there are many vision problems that can limit our visual perception. In most cases, an optimally fitted pair of glasses with the right lenses can help you see clearly once more. BETTER VISION explains:
> What type of lens is suitable for different visual impairments?

Many eye diseases can have an impact on our vision – and dire consequences for the way we perceive the world around us. This includes everything from the more minor eye diseases such as chronically dry eyes, vitreous opacities and squinting to cataract, glaucoma and macular degeneration. > But what are the most common eye diseases and how can you recognize them?

So are all of these terms and processes mixed up in your head? Don't sweat it! As you can see, the human eye is a highly complex organ that works closely with the brain; in fact, it's often regarded as the window to the brain. Hardly any other one of our senses gives us so much information about our environment, daily life or the people around us – and, ultimately, about ourselves.

## This might also interest you

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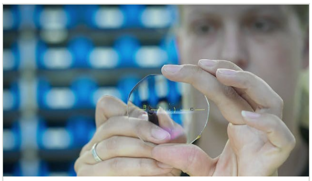

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